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Analysis of the Waste Management Practices at Bosnia and Kosovo Base Camps

C. James Martel

April 2003

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Cold Regions Research and Engineering Laboratory
72 Lyme Road
Hanover, New Hampshire 03755

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In June 2002, the main American base camps in Bosnia and Kosovo were visited to record the types of facilities being used for waste management and to identify any lessons to be learned. This study concluded that the Army should develop a deployable wastewater treatment system for base camps. Development of such a system would avoid the costly set-up and take-down operations required with conventional plants. Also, Eagle Base and Camp Bondsteel would benefit from installing composting operations for sludge stabilization and disinfection. The water supplies are potable at both locations. There is no longer a need to supply drinking water in plastic bottles, so eliminating them will significantly reduce the solid waste stream.

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PREFACE

This report was prepared by Dr. C. James Martel, Environmental Engineer, Applied and Military Engineering Branch, Cold Regions Research and Engineering Laboratory, U.S. Army Engineer Research and Development Center, Hanover, New Hampshire.

This project was funded under BC002 – *Winter Base Camp Construction & Maintenance Operations*. The author acknowledges Dr. Raymond Rollings, Project Manager, without whose support this project would not have taken place. A special thanks goes to Nicholas Collins, who accompanied the author on the trip. He provided a wealth of information on who to contact, and how to arrange this trip.

At the time of publication of this report, Director of ERDC was Dr. James R. Houston. Commander was COL James W. Morris.

AN ANALYSIS OF THE WASTE MANAGEMENT PRACTICES AT BOSNIA AND KOSOVO BASE CAMPS

C. JAMES MARTEL

1 INTRODUCTION

Background

As part of NATO led peacekeeping operations, the Army has constructed many base camps in the Balkans. Almost 10,000 troops were stationed at 12 of these base camps in May 2002. Most of the soldiers were stationed at Eagle Base (1260) in Bosnia and Camp Bondsteel (3950) in Kosovo. In addition to the military population, there is approximately an equal number of DOD civilians and contractors who work on-post. The normal tour of duty for each soldier is 6 months. DOD civilians and contractors can be stationed there for several years, depending on the workload.

U.S. forces entered Bosnia-Herzegovina in December 1995 under Operation Joint Endeavor. It was supposed to be a 6 month "temporary" occupation, so tent camps were quickly set up to establish a presence and keep the troops sheltered and out of the mud. However, it soon became obvious that peacekeeping would require a longer commitment. Since then, military issue tents have been replaced with SEA (South East Asia) huts, which are large plywood buildings like the ones used in Vietnam. Each hut has heat and air conditioning, and access to toilet and shower facilities.

U.S. forces entered Kosovo in June 1999 following NATO Operation Allied Force. Based on lessons learned in Bosnia, the base camp planners decided to proceed directly to construction of SEA huts rather than tents. In a marvel of engineering achievement, Camp Bondsteel and Camp Montieth were constructed in a 4-month period. Today, these base camps have the same facilities as those in Bosnia.

Brown and Root Services (BRS) of Houston, Texas, deserves much of the credit for constructing and maintaining all the base camps in the region. They have their own base camps, which contain most of the support personnel and equipment.

Objective

In fiscal year 2002, CRREL received funding for work related to design, construction, and maintenance of base camps. One area of concern was the waste management practices. Base camps are considered only temporary installations, but they contain most of the utilities found at permanent installations. This "temporariness" presents a unique challenge to base camp planners

and designers. The objective of this study was to record the types of facilities being used and identify any lessons to be learned.

Scope

The study was conducted at Eagle Base in Bosnia, and Camp Bondsteel and Camp Montieth in Kosovo. These base camps were selected because they are the largest. Camp Comanche in Bosnia was also visited but it was being dismantled. Although we visited Camp Able Sentry in Macedonia, it was not of interest from a facilities point of view because it was served by nearby Skopje Airport.

2 EAGLE BASE, BOSNIA

Eagle Base is located near Tuzla at a former Yugoslav Air Force Base (Fig. 1). It is a 2.5-hour flight by C-130 from Ramstein Air Force Base in Germany. I arrived on 19 June 2002 in the late afternoon and stayed at the Audie Murphy Inn.

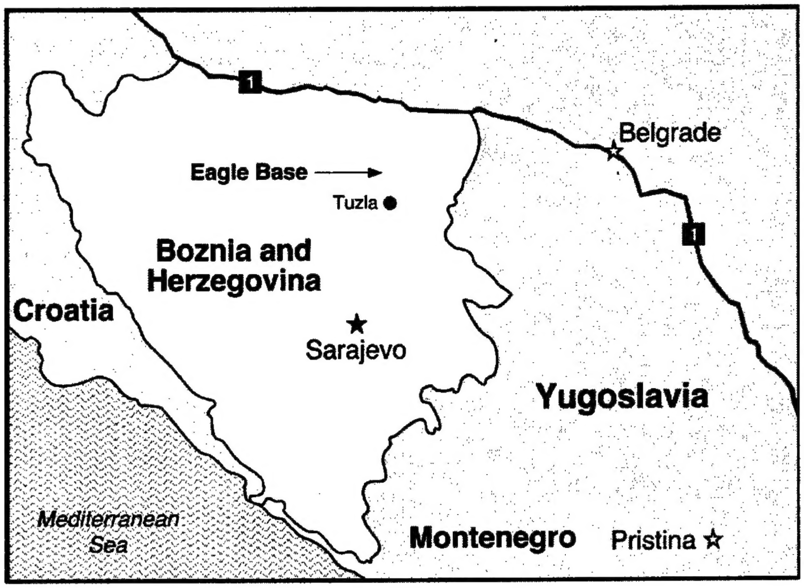

Figure 1. Bosnia, showing location of Eagle Base.

The next morning I met with James Lee, Environmental Officer, and Almir Zejicorovic, a Bosnian who served as DPW interpreter. We discussed the water supply, wastewater treatment, and solid waste management systems, and then went on a tour of each facility.

Wastewater treatment facility

The wastewater treatment facility is located at the south end of the base near the airfield. The original Yugoslav treatment plant had a 550-person capacity, so it was quickly overloaded when the Americans arrived with over 3000 soldiers. BRS tried several methods to upgrade the facility, including replacing pumps, cleaning of settling tanks, and bacterial augmentation. None of these measures worked, so a new treatment plant was constructed in 1999 at a cost of approximately $1,000,000. Another treatment plant, using the same technology, was constructed at neighboring Camp Comanche. At the time of my visit, the Camp Comanche plant had been dismantled and was headed for Camp McGrath in Kosovo. Dismantling this unit required the manual removal of thousands of bolts. Reassembly at Camp McGrath will require an equally laborious task. No information was available on the cost of this effort.

The old Yugoslav wastewater treatment facility consisted of a bar screen, Imhoff tank (Fig. 2), and what can be described as an inclined concrete channel trickling filter (Fig. 3). It was designed so that the primary effluent from the Imhoff tank was applied at the top of the reactor. The wastewater then flowed down a series of concrete channels, which were probably filled with 50-

to 76-mm (2- to 3-in.) trap rock. Treatment occurred as the wastewater came in contact with the microorganisms attached to the trap rock and the concrete channels. This is a rather unique process and not used in the U.S., but is similar to the trickling filter process. Sludge collected in the Imhoff Tank was placed on sand beds for dewatering. Effluent from the plant was discharged into a ditch, which flowed to the River Spreca.

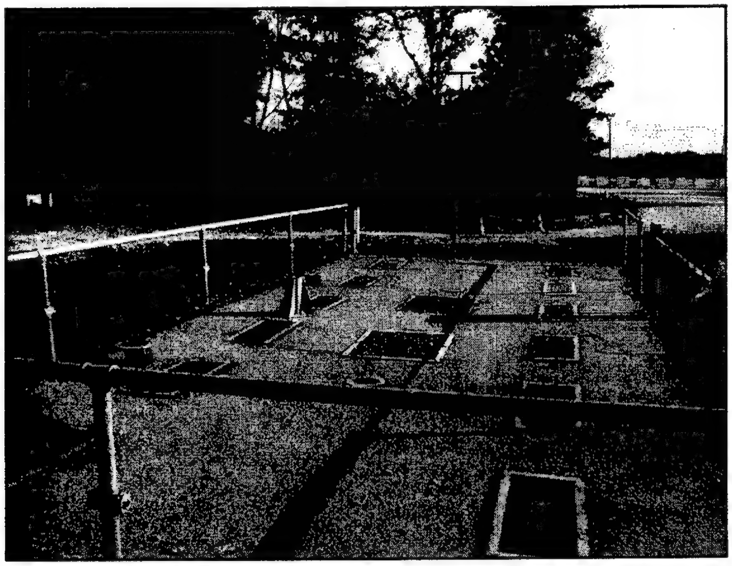

Figure 2. Top of Imhoff tank.

Figure 3. Concrete channel trickling filter of old Yugoslav wastewater treatment plant.

The new treatment plant uses the existing bar screen and Imhoff tank. However, the old trickling filter was replaced with two sequencing batch reactors (Fig. 4) having a combined ca-

pacity of 1136 m^3/day (300,000 gal./day). The reactors were designed and manufactured by Farmatic Anlagenbau GmbH. Operation began in December 1999. Information about the new plant is shown in Table 1.

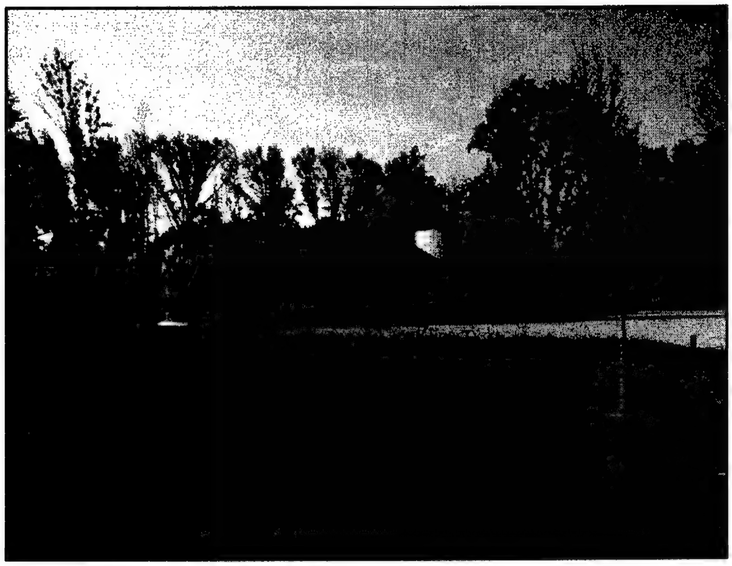

Figure 4. Sequencing batch reactor units.

Mr. Lee indicated that his main concern was the lack of control over contract disposal of sludge. The U.S. Government could be held liable for illegal disposal practices. As a result, he plans to institute a composting operation, which would disinfect the sludge and make it usable for land application. Wood chips would come from trees cut down during Mine Clearing and Proving (MCAP) operations.

The effluent produced by the wastewater plant is of good quality and meets U.S. Secondary Standards (30 mg/L BOD and 30 mg/L TSS). Reportedly, it is of a better quality than the receiving water.

The present doctrine of using existing treatment facilities for base camps was not acceptable in the Bosnian case. The plant was quickly overloaded and failed to meet secondary discharge standards. Consequently, an expensive conventional secondary plant was built, which must be disassembled when the base camp is deactivated. The lesson learned from this experience is that a deployable wastewater treatment plant is needed.

Table 1. Wastewater treatment and disposal fact sheet for Eagle Base.

Date	20 June 2002
Location	Eagle Base, Tusla Bosnia
Point of contact	James Lee, Matija Lesic
Service population	4000 (est.) during Transfer of Authority only. The regular population is around 2000 to 2200.
Flow rate	1000 m^3/day (264,172 gal./day)
Wastewater characteristics	368 mg/L BOD; 455 mg/L TSS
Collection system	Underground sewer—80% Tank trucks—20%
Treatment processes	Bar screen, grinder, storage tank (8- × 5- ×10-m Imhoff tank), flowmeter, two sequencing batch reactors (600 m^3 each), discharge to drainage ditch that flows into the River Spreca. No disinfection. The sludge is pumped to a storage tank and mixed by paddle stirrers. Sludge is removed by contractor and transported to a treatment plant near the town of Gradacac where the sludge is treated to Class A Standards.
Effluent characteristics	7.6 mg/L TSS from reactor 1; 9.4 mg/L TSS from reactor 2. 10.0 mg/L BOD from reactor 1; 10.2 mg/L BOD from reactor 2. BOD was reduced to 3–9 mg/L after removal of food grinders.
Discharge req.	30 mg/L TSS and BOD, 80 mg/L COD
Past practices	Old Yugoslav plant consisting of bar screen, Imhoff tank, channel aerator, discharge to River Spreca. Sludge was dewatered on drying beds. Final disposition unknown.
Future plans	Sludge composting operation using wood chips from Mine Clearing and Proving (MCAP) operation. Incorporate some solid wastes and food wastes into composting operation.
Lessons learned	It would have been cheaper and faster to build a modern STP rather than utilize the existing antiquated and undersized facility.
Comments	DPW is concerned about the high cost and difficulties involved with hauling wastes in a deployed area. Other European operations are saving money by composting.

Solid waste management facility

Eagle Base generates the same types of waste as a small community, with the exception of an extraordinarily large volume of plastic water bottles. Bottled water became the beverage of choice during the early days of base camp life when a safe, potable water source was not available. This practice is very expensive and plans are to switch to a local water source later this year.

Refuse is collected in dumpsters and picked up by compactor trucks. It is then burned in a waste-fuel-fired, hot-air curtain incinerator. Reportedly, this incinerator requires waste wood and paper to operate properly. This need negates any wood and paper recycling effort. Figure 5 shows a typical pile of wood waste. Most of the wood waste comes from pallets. Aluminum cans are the only items that are recycled. Table 2 presents more information on the solid waste system at Eagle Base.

Figure 5. Waste woodpile at Eagle Base.

Table 2. Solid waste management fact sheet for Eagle Base.

Date	20 June 2002
Location	Eagle Base, Tusla, Bosnia
Point of contact	James Lee
Service population	3000–4000
Sources	Eagle base, and three FOB's, and three hilltops.
Types and quantities	2294 m^3/day (3000 yd^3/day). Wood, mixed paper, plastic bottles, mixed packaging, food waste, medical wastes, expired drugs, hand towels, and unpurchased merchandise.
Onsite handling and storage	Thirty-one 3.8-m^3 (5-yd^3) dumpsters and fifty-one 340-L (90-gal.) totes.
Collection method	Compaction type garbage trucks.
Processing technique	Separation of inappropriate wastes.
Disposal method	Incineration (hot air curtain, waste fuel fired).
Hazardous wastes	Separate collection and disposal.
Recycled materials	Aluminum cans.
Lessons learned	Can't recycle products with high BTU potential because it would harm incinerator operations. The incinerator needs the recyclables as a fuel source.
Comments	None

Hazardous wastes are handled separately and stored at nearby Camp Fiala, a base camp operated by BRS (see Fig. 6). These wastes are then transported to Germany and other locations for disposal.

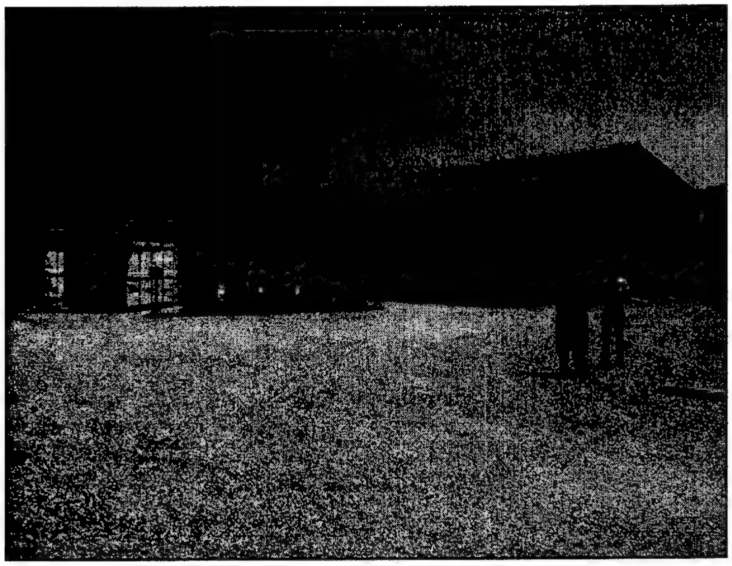

Figure 6. HAZMAT storage facility at Camp Fiala.

3 CAMP BONDSTEEL, KOSOVO

Camp Bondsteel is located near Urosovic, on 1000 acres of farmland (see Fig. 7). It is the headquarters for the U.S. Sector in southeast Kosovo. It was named after Vietnam War Medal of Honor recipient Sgt. James L. Bondsteel.

I arrived at Skopje International Airport in Macedonia on Saturday, 22 June, and was driven to Camp Bondsteel under armed escort. My point of contact was David Carte, Environmental Engineer, Task Force Falcon.

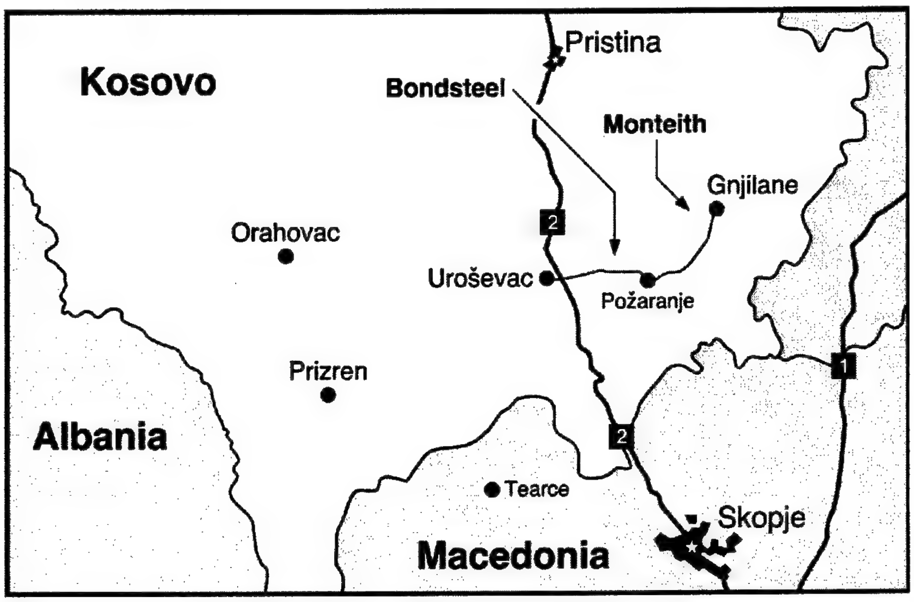

Figure 7. Locations of Camp Bondsteel and Camp Monteith in Kosovo.

Wastewater treatment facility

The wastewater treatment facility is located near the entrance to the camp. On 23 June 2002, Wiley Cawthra, Superintendant, gave us a tour of the plant. Details of the plant are listed in Table 3. Photos of the main unit operations are shown in Figures 8–15.

According to the May Monthly Report (see Table 4), the average carbonaceous biochemical oxygen demand (CBOD), total suspended solids (TSS), and chemical oxygen demand (COD) concentrations in the treatment plant effluent were almost as low as those in the pond effluent. The average CBOD in the pond effluent was only 1.0 mg/L less than the average CBOD in the treatment plant effluent. Similarly, the average TSS and COD concentrations in the pond effluent were only slightly lower than those in the plant effluent. The only parameter that was appreciably reduced by the ponds was the NH_3-N concentration, which was reduced from 34 to 15 mg/L. These data suggest that it is not beneficial to discharge the treatment plant effluent to the ponds.

Table 3. Wastewater treatment and disposal at Camp Bondsteel.

Date	23 June 2002
Location	Camp Bondsteel, Kosovo
Point of contact	Wiley Cawthra
Service population	4200 est.
Flow rate	± 1230 m^3/day (± 325,000 gal./day)
Wastewater characteristics	1100 mg/L COD; 80 mg/L NH_3; 500 mg/L TSS; 270 mg/L BOD
Collection system	14.5 km (9 miles) of 152- to 559-mm (6- to 22-in.) pipe 65–70%, rest hauled in from other base camps.
Treatment processes	Inclined screens—plastic media tower—activated sludge—secondary clarifier—three polishing ponds. Sludge is aerobically digested, dewatered with a filter press, stored in plywood containers, and stacked in a lagoon.
Effluent characteristics	95% compliance, occasional TSS problem.
Discharge req.	25 mg/ L BOD, 30 mg/L TSS, 6.0–9.0 pH.
Past practices	Started out with truck collection and disposal to pit, then to a four-cell aerated lagoon, then to conventional secondary plant.
Future plans	Pretreatment by primary clarification and further aeration. Change portalet chemicals. Winter protection for dewatering operations. More pressure washers.
Lessons learned	Need better master planning to project growth. Present plan did not include workers—portalets not considered—BRS has 3600 people on-site.
Comments	Good communication between BRS and DPW. BRS needs a recommendation on what to do with stacked sludge.

Table 4. Average performance of Camp Bondsteel treatment plant during May 2002.

Water quality parameter (mg/L)	Influent	Treatment plant effluent	Pond effluent		
			#1	#2	#3
CBOD	250	9			8
TSS	327	34			32
COD	786	126	113	109	121
NH_3-N	81	34	27	22	15

The TSS concentration in the effluent from both treatment plant and ponds was greater than 30 mg/L, which is a violation of the discharge standard. If this continues, remedial action may be necessary.

As shown in Figures 12 and 13, sludge is placed in plywood boxes and stored in a lagoon located on-site. The lagoon is near capacity, so it will need emptying, or an alternative disposal method will be needed. At the time of my visit, Mr. Carte was exploring the option of removing all the plywood boxes and burying them in a local landfill. His main concern was possible local contamination attributable to inadequate burial.

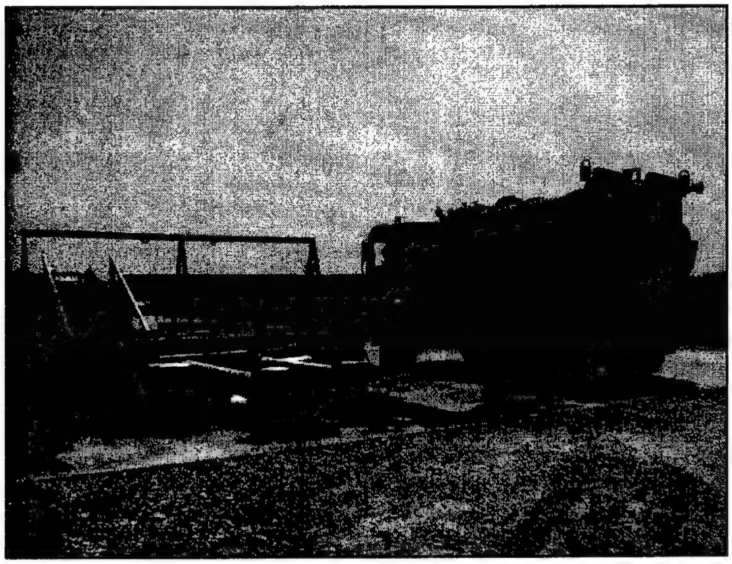

Figure 8. Sewage receiving station.

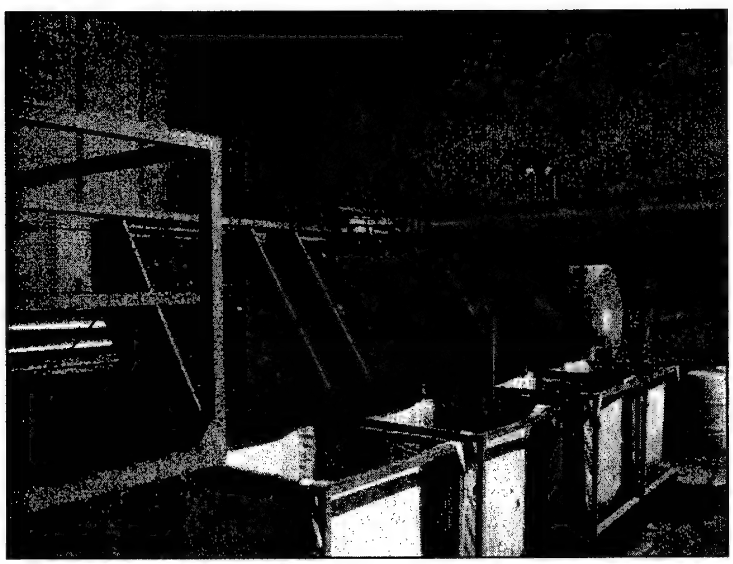

Figure 9. Inclined screens for primary treatment.

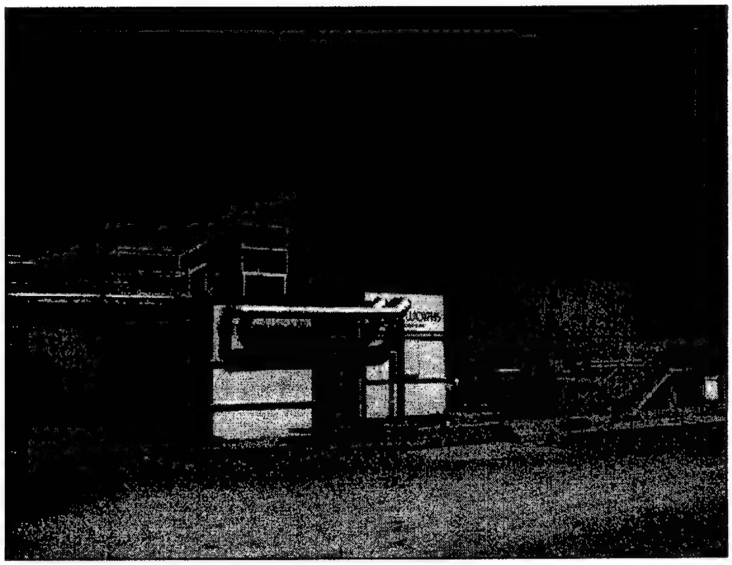

Figure 10. Plastic media tower and equalization tank.

Figure 11. Aerated polishing lagoons.

Figure 12. Sludge filter press.

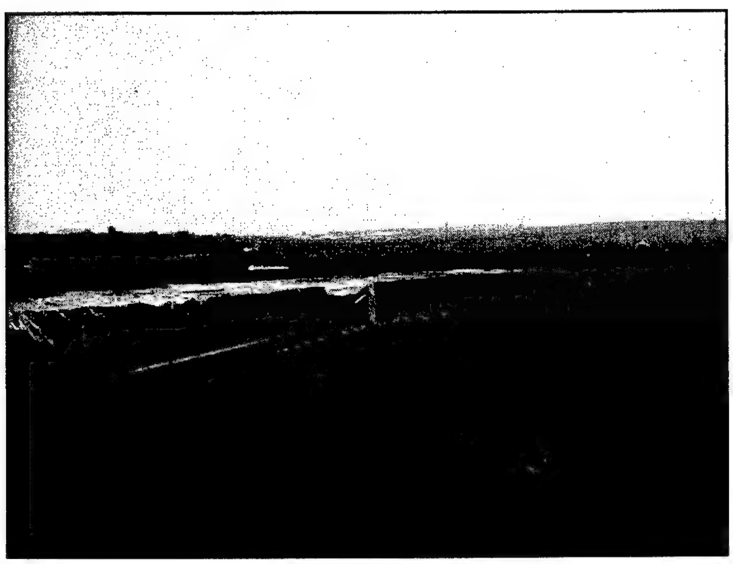

Figure 13. Sludge storage lagoon.

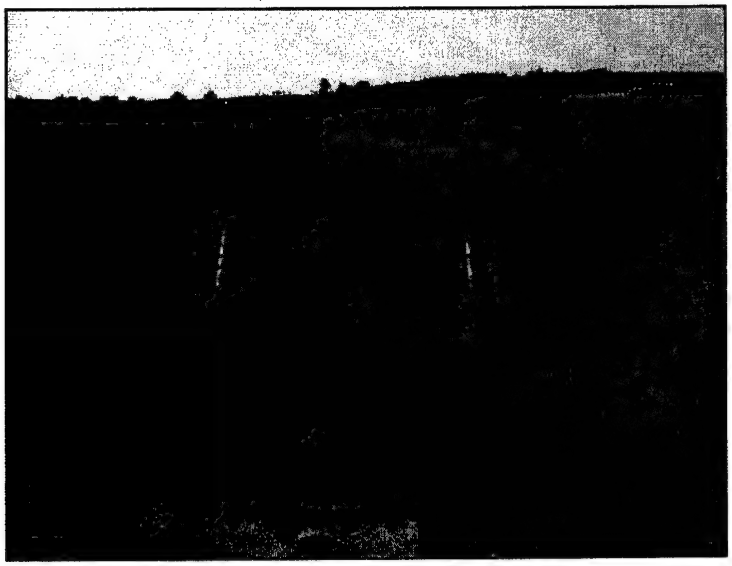

Figure 14. Effluent receiving stream.

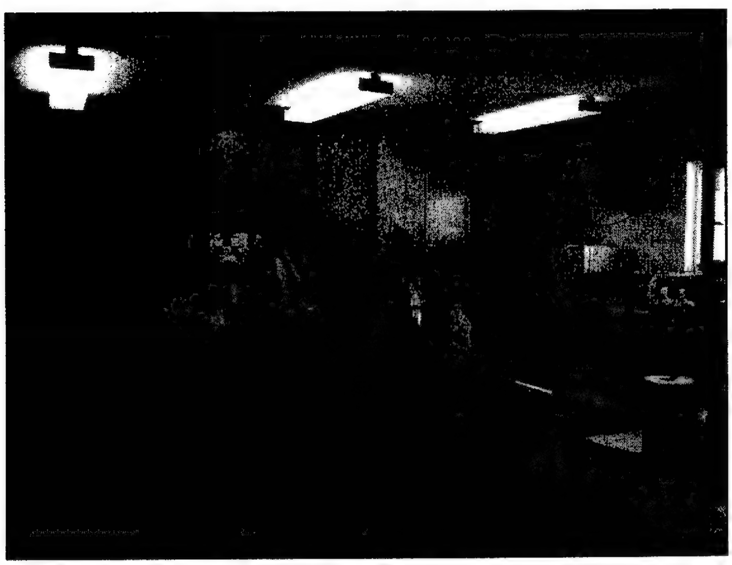

Figure 15. On-site wastewater laboratory.

Solid waste management facility

All solid wastes from Camp Bondsteel as well as Camp Monteith are collected and incinerated at the Camp Bondsteel facility. Details of the facility are shown in Table 5. Photos of the screened incinerator and wood waste pile are shown in Figures 16 and 17, respectively. Although this type of incinerator would not meet stateside emission standards, it does control disease vec-

tors and significantly reduces the volume of solid wastes. Ash from the incinerator is piled on-site and then buried in a landfill.

Table 5. Solid waste management fact sheet for Camp Bondsteel.

Date	24 June 2002
Location	Camp Bondsteel
Point of contact	Ray Alderson
Service population	10,000 including contract local nationals.
Sources	Packaging, construction material.
Types and quantities	Plastics, glass, lumber is probably the biggest fraction.
On-site handling and storage	Dumpsters.
Collection method	Ten collection trucks.
Processing technique	Trash deposited in pole barn and searched by local nationals for explosives and hazardous wastes.
Disposal method	Incinerated in enclosed burn pit, transferred to cool down pad, and trucked to landfill for disposal.
Hazardous wastes	Stored in designated areas and transported to treatment facility.
Recycled materials	Lumber sent to fire demo pit for training. No recycling of cans and bottles. No paper recycling because of operational secrecy.
Lessons learned	Should have put garbage grinders in dining facilities so garbage would go to WWTP rather than solid waste facility.
Comments	All solid waste generated at Camp Monteith is incinerated at Bondsteel.

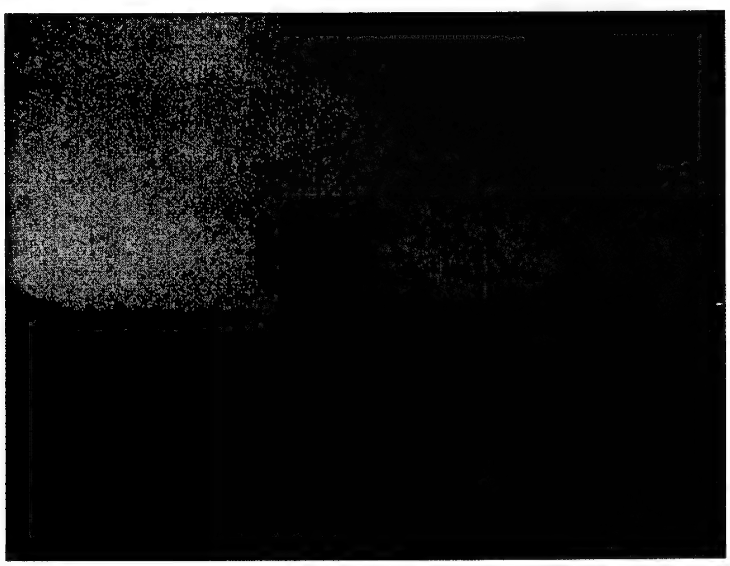

Figure 16. Trash incinerator at Camp Bondsteel.

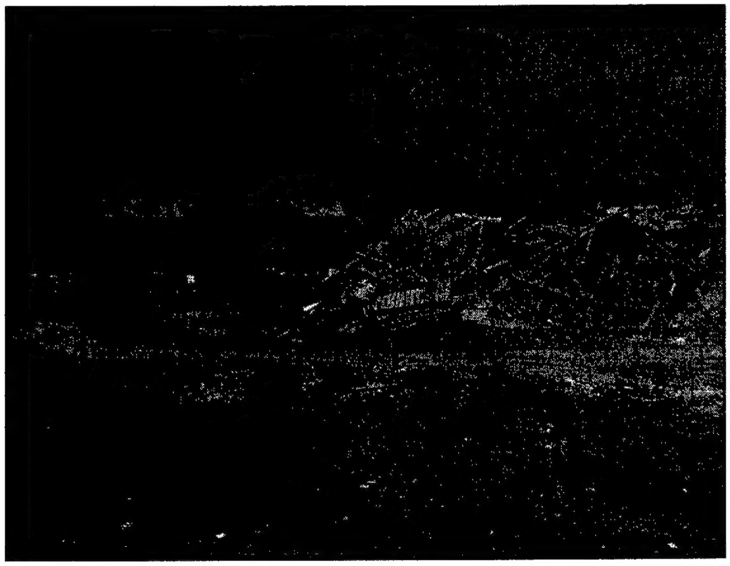

Figure 17. Wood wastes at Camp Bondsteel.

4 CAMP MONTEITH, KOSOVO WASTEWATER TREATMENT FACILITY

About a 1-hour drive east of Camp Bondsteel is Camp Monteith. Located near the town of Gnjilane, it was a Yugoslav Army barracks that was heavily damaged during the NATO air campaign. The camp is named after World War II Medal of Honor recipient Army 1st Lt. Jimmie W. Monteith Jr. Approximately 1400 troops are stationed at this base camp.

Only information on the wastewater treatment facility will be presented in this report. As indicated earlier, Camp Monteith has no solid waste facility. All solid wastes are trucked to Camp Bondsteel.

Camp Monteith has the same type of wastewater treatment facility as Camp Bondsteel. Wiley Cawthra is also the Superintendent of the plant. Details of the facility are shown in Table 6. A photo of the facility is shown in Figure 18.

The May 2002 performance data shown in Table 7 indicate that the treatment plant is performing well within the requirements of the discharge permit. Average CBOD and TSS concentrations in the effluent were only 4.5 and 9.0 mg/L, respectively. These data also suggest that the treatment plant at Camp Bondsteel may be underperforming, as it has the same basic treatment plant.

Table 6. Wastewater treatment and disposal fact sheet for Camp Monteith.

Date	23 June 2002
Location	Camp Monteith, Kosovo
Point of contact	Wiley Cawthra
Service population	1400 (est.)
Flow rate	492 m^3/day (130,000 gal./day)
Wastewater characteristics	240 mg/L BOD; 650 mg/L COD; 275–300 mg/L TSS; 75 mg/L NH_3.
Collection system	7.2 km (4.5 miles) of pipe, 67% new, 33% old pipe that occasionally needs patching owing to war damage.
Treatment processes	Similar to Bondsteel except there are no polishing ponds. Discharge is to a ditch. All biosolids are trucked to Bondsteel.
Effluent characteristics	6–8 mg/L BOD; 45–60 mg/L COD; 2 mg/L TSS; 2–6 mg/L NH_3.
Discharge req.	Same as Bondsteel. 25 mg/L BOD, 30 mg/L TSS, 6.0–9.0 Ph.
Past practices	Holding tanks, truck to Bondsteel—Built collection system for holding tanks, truck to Bondsteel—Built present treatment plant.
Future plans	None
Lessons learned	Processes work when properly sized. Could handle 30–34 m^3/day (8000–9000 gal./day) more of outpost waste.
Comments	None

Table 7. Average performance of Camp Monteith treatment plant during May 2002.

Water quality parameter (mg/L)	Influent	Treatment plant effluent
CBOD	240	4.5
TSS	255	9
COD	673	63
NH_3-N	64	2.3

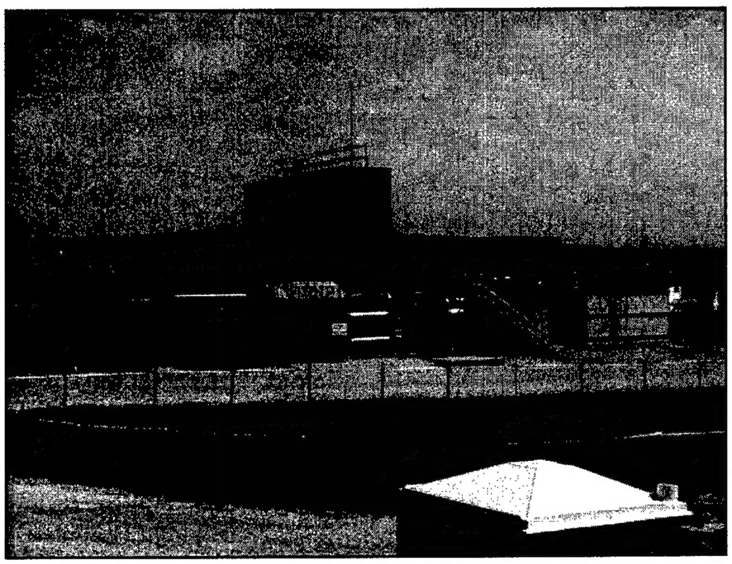

Figure 18. Camp Monteith wastewater treatment plant.

5 CONCLUSIONS

Eagle Base should install a composting operation for sludge disinfection. A ready and cheap supply of wood chips is available from MCAP operations. The composted sludge would then be suitable for land application without fear of spreading disease among the local population.

The water supplies are potable at both locations. There is no longer a need to supply drinking water in plastic bottles. Eliminating the plastic bottles will significantly reduce the solid waste stream.

Camp Bondsteel should also consider installing a biosolids composting operation. This will eliminate the sludge storage problem in the lagoon.

Camp Bondsteel should try to improve the performance of their treatment plant to match that of the Camp Monteith plant. A bypass should be constructed to allow direct discharge of the treatment plant effluent to the receiving stream. The polishing ponds could be converted to a composting facility.

The Army, in conjunction with BRS, should develop a deployable wastewater treatment system for base camps. Development of such a system would avoid costly set-up and take-down operations required with conventional plants.